

ON A CARBONIFEROUS FISH-FAUNA FROM THE MANSFIELD DISTRICT, VICTORIA.

BY ARTHUR SMITH WOODWARD, LL.D., F.R.S.

I.—INTRODUCTION.

The fossil fish-remains collected by Mr. George Sweet, F.G.S., from the red rocks of the Mansfield District, are in a very imperfect state of preservation. They vary considerably in appearance according to the nature of the stratum whence they were obtained. The specimens in the harder calcareous layers retain their original bony or calcified tissue, which adheres to the rock and cannot readily be exposed without fracture. The remains buried in the more ferruginous and sandy layers have left only hollow moulds of their outward shape, or are much decayed and thus very difficult to recognise. Moreover, the larger fishes are represented only by scattered fragments, while the smaller fishes, even when approximately whole, are more or less distorted and disintegrated.

Under these circumstances, with few materials for comparison, it is not surprising that the late Sir Frederick McCoy should have failed to publish a satisfactory account of the Mansfield collection. With great skill, he selected nearly all the more important specimens to be drawn in the series of plates accompanying the present memoir. He also instructed and supervised the artist, so that most of the principal features of the fossils were duly emphasised. His preliminary determinations, however, published in 1890,¹ are now shown to have been for the most part erroneous; while his main conclusions as to the affinities of

¹ F. McCoy, "Report on Paleontology for the Year 1889," Victoria.—Ann. Rep. Sec. Mines, 1889 (1890), pp. 23, 24.

the fish-fauna are proved to be without real foundation. Far from displaying a "Mixture of Lower Devonian, Upper Devonian, and types related to some of the Calciferous Sandstone series," as McCoy supposed, the Mansfield fishes are typically and essentially Carboniferous, as the following technical descriptions will demonstrate. Of the six genera represented in the collection, one (*Eupleurogmus*) is too imperfectly known for discussion; four of the others (*Acanthodes*, *Ctenodus*, *Strepsodus*, and *Elonichthys*) have hitherto been discovered only in the Permian and Carboniferous of Europe, and in the Carboniferous of North America; while the sixth (*Gyracanthides*) is related to an essentially carboniferous fish in the northern hemisphere and bears every mark of belonging to the same late Palæozoic period.

The genus *Gyracanthides* is, indeed, a remarkable discovery. As correctly recognised by McCoy, it is closely allied to *Gyracanthus*, which is widely distributed as a characteristic fossil in the Carboniferous of the northern hemisphere and seems to be also represented by a few small spines in the Lower Devonian. The new specimens prove that *Gyracanthides* is a typical Acanthodian, belonging either to the Diplacanthidæ or to a distinct family which marks the culmination of the Diplacanth series. The enlargement of the pectoral fins, the reduction and forward displacement of the pelvic fins, and the absence or peculiar modification of the intermediate spines, are features indicating its high degree of specialisation. It occupies the same position among Diplacanthids as that occupied by the Permian species of *Acanthodes* among the Acanthodians with one dorsal fin.¹ It shows that the direction of specialisation was identical in the two great groups of Acanthodians, and was analogous to the specialisation observable in later geological periods among Selachians and Teleosteans.

The total assemblage of fishes in the red rocks of Mansfield is such as occurs usually in estuarine or freshwater strata in the northern hemisphere; but all the genera are likewise met with

1. A. S. Woodward, "Catalogue of Fossil Fishes in the British Museum," pt. ii. (1891), p. 5.

occasionally in marine sediments. Their association with numerous remains of land-plants at Mansfield, however, is suggestive at least of estuarine conditions. They do not appear to exhibit any essential change as they are traced through the successive beds in the section so carefully worked and described by Mr. Sweet.¹

II.—SYSTEMATIC DESCRIPTIONS.

Subclass ELASMOBRANCHII.

Order Acanthodii.

Family GYRACANTHIDÆ.

An imperfectly definable family of round-bodied and depressed Acanthodians, with the pectoral fins very large and the pelvic fins advanced far forwards. Dorsal and anal fins much reduced and sometimes apparently without spines.

This family has hitherto been known only by detached paired fin-spines, other paired spines or plates, and small dermal tubercles, the majority belonging to one genus, *Gyracanthus* of Agassiz. The specimens of the new genus *Gyracanthides* now described, show for the first time the depressed, rounded form of the trunk and the relative position of the fins.

Genus GYRACANTHIDES, McCoy.

[Ann. Rep. Sec. Mines, Victoria, 1889 (1890), p. 24.]

Body short and broad. Teeth minute or absent; no circum-orbital plates. Both pectoral and pelvic fins with spines, the latter about half as large as the former. Pectoral fin-spines much compressed from above downwards, arched from side to side; their base of insertion extensive, with the internal cavity open for a considerable length posteriorly; the longitudinal mesial line of their narrow anterior face defined by the superficial

¹ G. Sweet, "On the Discovery of Fossil Fish in the Old Red Sandstone Rocks of the Mansfield District."—Proc. Roy. Soc. Victoria, n.s., vol. ii., (1890), pp. 1-14, pls. 1-3.

ornament, which consists of parallel, oblique, transverse ridges, diverging in pairs from this line over the flattened upper and lower faces and inclined towards the inserted extremity; their narrow posterior face impressed by a median longitudinal groove but without denticles. Pelvic fin-spines ornamented like the pectorals, but rounded in transverse section at the base and nearly straight. Posterior dorsal and anal fins relatively small, with a broad, laterally-compressed anterior spine, which is ornamented with longitudinal tuberculated ridges; caudal fin slightly forked. Two pairs of hollow, broad, triangular, free spines, of fibrous texture, fixed near the insertion of the pectoral fin-spines.

This fish agrees with *Gyracanthus* in the ornamentation of its pectoral fin-spines and the nature of its free spines; but there is as yet no evidence that the last-mentioned genus possessed pelvic fin-spines or any median fin-spine. It may also be added that the pectoral fin-spines of *Gyracanthides* hitherto discovered do not exhibit any worn surfaces, while the corresponding spines of *Gyracanthus* are often much abraded and destroyed at the tip.

GYRACANTHIDES MURRAYI, sp. nov. Plates I, II, III, IV;
Plate V, figs. 1, 2; Text-figures 1, 2.

1890. *Rhytidaspis murrayi*, F. McCoy. *Loc. cit.* p. 23
(name only).

1890. *Chiraropalus langtrei*,* F. McCoy. *Loc. cit.* p. 24
(name only).

Type.—Head and abdominal region of fish showing pectoral spines (partly shown in Pl. I, fig. 1).

Specific Characters.—The type species, usually attaining a length of about 0.5 m., sometimes perhaps much larger, with the pectoral fin-spines extending nearly half of this length. Width between the insertion of the pectoral fin-spines probably exceeding the length of the head and branchial region in front of them; the same measurement slightly more than twice as great as the width between the insertion of the pelvic fin-spines, of which the

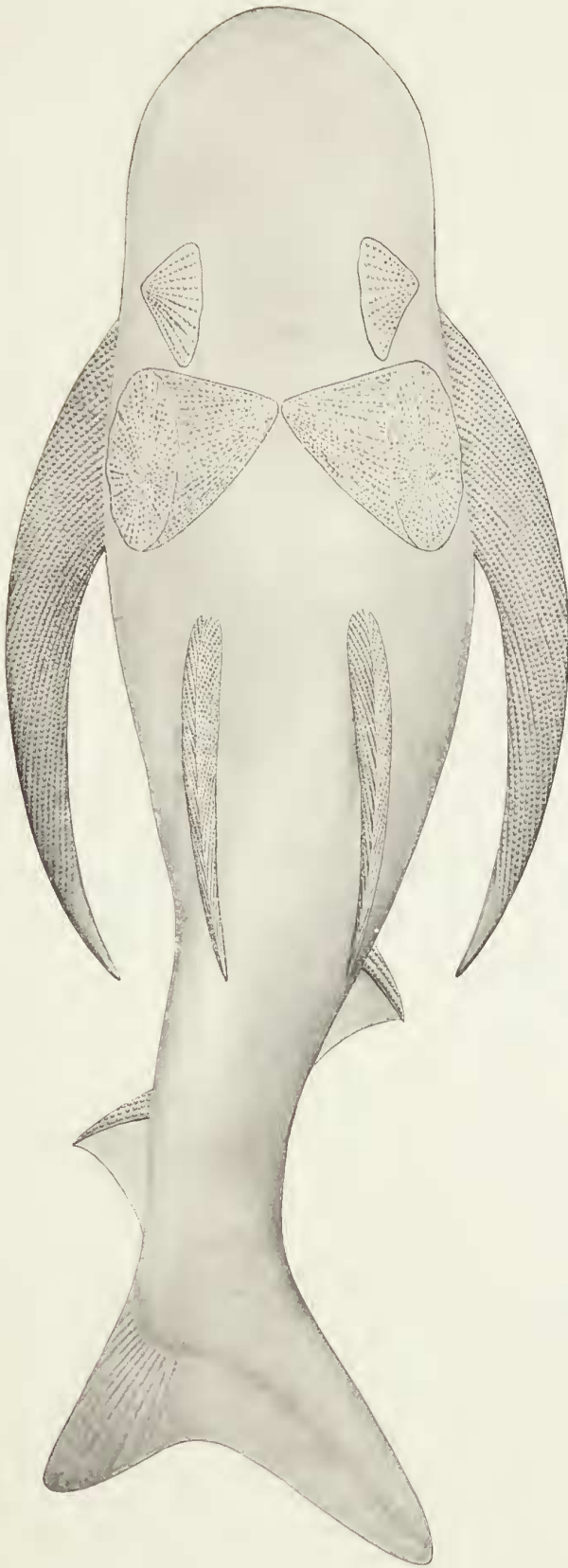


Fig. 1. *Gyraacanthides murrayi*, A. S. Woodw.; restored drawing of fossil, much reduced, head and abdominal region seen from below, tail twisted to exhibit side-view.

distal ends do not appear to have extended further back than the tips of the pectoral spines. Ridged ornament of both paired spines tuberculated; the number of ridges cut by a cross-section of a full-grown pectoral fin-spine just behind its base of insertion about 13 to 15 on each face.

General Form.—The specimens of the head and abdominal region of this species are always exposed either from above or below, and prove that the greater part of the body was originally rounded or depressed in transverse section. The only known example of the hinder part of the caudal region (Pl. V, fig. 1) is displayed in side-view, and indicates that this part was more laterally compressed. The type-specimen seems to show the complete extent and shape of the head and branchial region, while this and another imperfect fossil (Pl. I, fig. 7), with the caudal region just mentioned, appear to justify the specific diagnosis, which is illustrated by the accompanying restored sketch (text-fig. 1).

Head.—So far as preserved in the type-specimen, the head exhibits nothing but the usual close armour of dermal tubercles, without any traces of teeth or circumorbital plates. It also lacks indications of branchial arches. The cartilage of the endoskeleton cannot have been sufficiently well calcified for preservation.

Pectoral Fin-spine.—The paired fins are represented in the fossils solely by their anterior spines, which are always imperfect and often preserved only in the form of natural moulds or impressions. Owing to its vertically-compressed shape the pectoral fin-spine is invariably exposed either from above or below, and it is shown on both sides of the type-specimen, of which the left portion is seen in Pl. I, fig. 1 (*e*). Parts of this spine are also seen on both sides of the fossil in Pl. I, fig. 7 (*b*), Pl. II, fig. 2 (*b*), and Pl. III, fig. 1. More satisfactory examples for description are drawn in Pl. II, fig. 1 (*e*) and Pl. IV. As indicated by the two specimens last mentioned, the base of insertion is much extended, its extent being probably greater than one-third of the total length of the spine; but this base is not very deep, and it appears to have been only quite slightly produced forwards in front of the exerted and ornamented

portion. The width of the exerted portion gradually increases to its maximum opposite the hinder part of the inserted base, and then the spine gradually tapers as it curves into the long and slender extremity, which is observable through a thin film of intractable matrix in the fossil represented in Pl. III, fig. 1. There is no evidence of the shortening of the spine by wear during life, such as occurs commonly in *Gyracanthus*. The vertical compression of the spine is well seen in a fragment of the type-specimen, which indicates that just at the hinder end of the inserted base the maximum vertical diameter equals nearly one-third of the width, while the dorsal and ventral faces are about equally flattened. These two faces are also similar in their ornamentation, which consists of oblique ridges, all surmounted with a regular row of smooth, rounded tubercles (Pl. IV, fig. 1*d*), and separated by shallow, smooth grooves, which are wider than the ridges themselves. All the ridges are complete from edge to edge of the spine, and thirteen to fifteen of them are cut by a transverse section at the hinder end of the base. Their direction tends to become more and more longitudinal as they are traced from the base towards the apex of the spine, and they may have been absent on the terminal portion. The anterior margin of the spine (Pl. IV, fig. 1*b*) is compressed to a sharp edge, along which the several ridges of the dorsal and ventral faces meet exactly in pairs. The posterior margin (Pl. IV, fig. 1*c*) is a narrow smooth area impressed by a deep longitudinal groove, which is represented by a ridge of sandstone in the fossil-casts (Pl. II, figs. 2*a*, 2*e*). It is evident that this groove was not quite median or bilaterally symmetrical. Its borders are not provided with any denticles. The calcified tissue of the spine is rather coarse, longitudinal vascular canals being visible to the naked eye, and imparting to longitudinal sections (Pl. III, fig. 1*b*) a fibrous appearance. The internal cavity is large, and a remnant of it seems to extend to the apex of the spine.

Anterior Free Pectoral Spine.—There is no clear evidence of fin-supports or a pectoral arch at the base of the pectoral fin-spines; but there are two pairs of wide, hollow, triangular spines, which may have projected freely from the ventral aspect of the

body in a manner not unusual among Acanthodians. Remains of the anterior pair of these peculiar spines are observable on both sides of the type-specimen just in front of the base of the pectoral fin-spine (one shown at *a* in Pl. I, fig. 1). An internal east of the corresponding spine in a second specimen is shown in Pl. I, figs. 7 (*a*), 7*a*. An imprint of one face evidently of the same spine, somewhat displaced, is also seen in Pl. III, fig. 1 (*c*); and variously imperfect detached specimens are represented in Pl. I, figs. 2-6. The structure is clearly a thin-walled, hollow, laterally-compressed cone, the length of its base-line equalling twice its height. Part of its calcified tissue is actually preserved in the type-specimen and in the original of Pl. I, fig. 4, exhibiting a very porous texture (see especially Pl. I, figs. 4*a*, 4*b*); and impressions are marked by the appearance of fibres radiating from the apex, crossed by certain lines of growth which are concentric with the basal edge. There are traces of a coarse tubercular ornament at the apex of the best-preserved spine in the type-specimen; and this ornament is shown to be confined to one face of the spine in the detached example of which one lateral impression is represented in Pl. I, fig. 2. The ornament consists of large, smooth tubercles arranged in ten to fourteen rows, which radiate from the apex and terminate at a short distance from the base of the spine, leaving a smooth area which was evidently the part originally inserted in the soft tissues. The tubercles increase in size towards the base of the spine, where they sometimes subdivide. As shown by various impressions (Pl. I, figs. 2, 3, 5), this ornamented face bears much resemblance to a dental plate of the Dipnoan fish, *Dipterus*; but even when the rest of the spine is not seen, the fossil is distinguished from a Dipnoan dental plate by its sharply-defined smooth area beyond the termination of the radiating ridges. The base-line of this spine seems to have been more or less coincident with the long axis of the trunk, while its apex, as crushed in the best-preserved fossils, is turned outwards.

Posterior Free Pectoral Spine.—The spine just described is not very large, the length of its base-line equalling only one-and-a-half times the maximum width of the pectoral fin-spine. The

free spines of the second pair are much larger and more elevated, the basal extent of each being about one-and-a-half times as great as that of the anterior spine, while the height somewhat exceeds this measurement. Parts of both of these large spines are seen in the type-specimen, that of one side being represented solely by its apex, while that of the other side is better displayed in several broken surfaces. Another good example is well shown in Pl. II, fig. 1, and lacks only the apex. A more imperfect specimen is seen near the front of the fossil represented in Pl. V, fig. 1. This spine is situated opposite and just on the inner side of the inserted part of the pectoral fin-spine. Like the smaller spine in front, it is a thin-walled, hollow, laterally-compressed cone, with its base-line more or less coincident with the long axis of the trunk, that is, parallel with the basal edge of the fin-spine. Its outer side (Pl. II, fig. 1*a*) is gently convex, with a sharply-bevelled area in front (resembling that of the corresponding spine in *Gyracanthus* and *Oracanthus*¹); its inner side is flattened or even slightly concave, and seems to be emarginate or excavated at its basal edge; its posterior aspect (Pl. II, fig. 1*b*) indicates the amount of the lateral compression. Remains of the actual tissue of the spine in the type-specimen show that it was very porous, with an appearance of fibres radiating from the apex towards the irregularly-crippled base (shown in internal cast in Pl. II, fig. 1*a*). An impression of the outer face in Pl. II, fig. 1 (*a*) reveals a close ornament of small, rounded tubercles, not clearly arranged along the radiating structural lines, which are here very conspicuous. These tubercles (Pl. II, fig. 1*e*) are not noticeable in any other specimen, probably on account of the state of preservation. They might even be marks of the shagreen granules of a piece of skin pressed against the spine in the fossil, like the tubercular impressions covering the base of the adjoining pectoral fin-spine; but they are more probably true ornament, for similar tubercles occur on the corresponding spines both of

1 J. W. Davis, "On the Fossil Fishes of the Carboniferous Limestone Series of Great Britain."—Trans. Roy. Dublin Soc. [2], vol. i. (1883), p. 529, pl. lxiii, fig. 1.

*Gyracanthus*¹ and *Oracanthus*². The narrow-ovoid basal opening of the large internal cavity of this spine is closed in two specimens by a separate basal plate, which seems to be in its natural position. This plate is well shown in the drawing of one side of the type-specimen (Pl. I, fig. 1*b*), and again in Pl. II, fig. 1*c*. It is quite as thin as the conical wall of the spine itself, and is clearly a separate element, calcified from its centre, from which structural lines radiate outwards. It exhibits traces of a tubercular ornament or of overlying shagreen-granules in both specimens. Its true nature is thus very difficult to understand, and it may even have been somewhat displaced in the fossils.

Pelvic Fin-spine.—The spines of the pelvic fins are very little more than half as large as those of the pectoral pair, while they are much more rounded in transverse section and straighter than the latter. The pelvic fins themselves are advanced so far forwards that the points of their spines scarcely extend backwards beyond those of the pectoral spines. Only one displaced pelvic spine is partly seen in an accidental fracture of the type-specimen, but the relative position of the pair is indicated in Pl. I, fig. 7 (*c*, *c'*), Pl. II, fig. 2 (*a*), Pl. III, fig. 1 (*b*), and Pl. V, fig. 1. In the first two figured examples just mentioned, each spine is represented solely by a natural mould of its internal cavity with scarcely any impression of the ornamented exterior face. In the original of Pl. III, fig. 1, however, where the spines are somewhat crushed together, fragments of their actual tissue are preserved, and impressions of their basal ends show the characteristic ornament forming parallel V-shaped ridges on the rounded lower face. In the original of Pl. V, fig. 1, there is also the basal end of the spine itself (*a*). These specimens, and the impression of one side of a detached example (text-fig. 2), show that the pelvic fin-spine was ornamented like the pectoral fin-spine, with continuous, tuberculated ridges, which are separated by comparatively wide, smooth grooves. The ridges tend to a more and more longitudinal direction as they are

1 A. S. Woodward, "Catal. Foss. Fishes, B.M.," pt. ii. (1891), p. 143.

2 J. W. Davis, *loc. cit.*

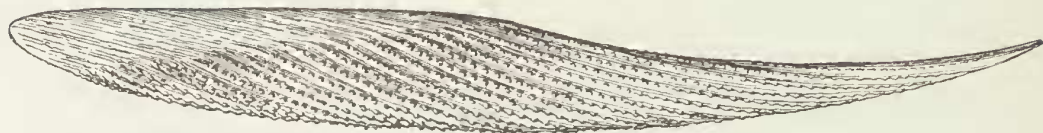


Fig. 2.—*Gyraacanthides murrayi*, A. S. Woodw.; pelvic fin-spine, side-view, nat. size.

traced from the base towards the slender apex of the spine, where there is an indication of a worn surface. The base of insertion is very extensive, as usual, its length probably equalling one-half the total length of the spine. One fine example apparently of this spine, obtained by Mr. Sweet from Bed W in the Mansfield section, is nearly twice as large as the original of text-fig. 2. Its outer ornamented face is broken away on the exposed side, but the tissue of the spine is sufficiently well preserved for microscopical examination. It exhibits a remarkably coarse vascular structure, identical with that described by Agassiz in *Gyraacanthus*.¹

Median Fins.—The specimen represented in Pl. V, fig. 1, is very imperfect anteriorly, showing only a hollow mould of parts of the pectoral fin-spines, one displaced large free pectoral spine, and part of one of the pelvic fin-spines; but it is important as displaying the caudal region of the fish, with traces of the median fins. This fossil seems to have been selected by McCoy (*loc. cit.*, p. 24) as the type of a species which he intended to describe under the name of *Chiraropalus langtrei*; but the paired spines already mentioned prove that it really belongs to the *Gyraacanthides* now under consideration. As shown by the figure, there is part of a fin-spine above the dorsal border of the trunk (at *c*) opposite the insertion of the pelvic fin-spine. In another more fragmentary specimen (Pl. V, fig. 2) there is also a small spine, chiefly shown by the mould of its internal cavity (*b*) nearly opposite a piece of spine (*a*) which seems to represent the pelvic fin-spine. The first example might possibly be the tip of one of

¹ L. Agassiz, "Reçh, Poiss. Foss.," vol. iii. (1843), p. 214, pl. A, fig. 6.

the pectoral fin-spines, but the second specimen cannot be explained in this manner. It is thus probable that there was a small anterior dorsal fin, with a spine, situated opposite to the insertion of the pair of pelvic fins. A posterior dorsal fin, opposed to the space between the pelvic and anal fins, is more satisfactorily preserved (Pl. V, fig. 1). Its slender anterior spine is nearly straight, and shown in a broken longitudinal section, which exposes the large internal cavity and appears to suggest that it bore an external coarse tubercular ornament of some kind. The fin itself is covered with dermal tubercles like those of the trunk. The length of its base-line seems to have slightly exceeded the height of its anterior spine, which can scarcely have equalled less than two-thirds the depth of the trunk at its insertion. The anal fin-spine, inserted opposite the hinder end of the posterior dorsal fin, is not much more than half as long as the dorsal fin-spine just described; but it is similar in character, with a very large central cavity. Its outer face is not seen in Pl. V, fig. 1, but an impression of it on the counterpart of the specimen represented in Pl. I, fig. 7 (see fig. 7*d*) exhibits an external ornament of a few large, tuberculated ridges, which are disposed longitudinally parallel with the hinder border and successively terminating at the front edge. One of the two specimens showing the anal fin-spine must be distorted, for in Pl. I, fig. 7, this spine (*e*) is observed quite near the apex of the pelvic fin-spines, while in Pl. V, fig. 1, it is further back (probably its natural position). The very stout caudal fin (Pl. V, fig. 1) is of the usual Acanthodian type, with no clear line of demarcation in the fossil between the upper caudal lobe and the dermal expansion beneath it.

Dermal Tubercles.—Both head and trunk are enveloped in a close and uniform covering of calcified dermal tubercles, which are not enlarged or modified even along the course of the lateral line. They are rhombic, usually almost equilateral in shape, and closely pressed together. Their inner face, seen on parts of the type-specimen, is flattened or even slightly concave, and it is pierced in the middle of the opening of a small, persistent pulp-cavity (Pl. I, fig. 1*a*). Their outer face is raised in the middle into a rounded boss, which sometimes exhibits a

feeble radiating crimping round the base. This is best shown in the original of Pl. II, fig. 2 (enlarged in fig. 2*c*), but is also observable in impression in other specimens from which the diagrams, Pl. I, fig. 7*b* and Pl. II, fig. 1*f*, have been made. Less accurate drawings are given in Pl. V, figs. 1*b*, 2*a*. The imperfect fossil represented in Pl. VI. also seems to be an impression of a fragment of this dermal armour, but the drawing exaggerates the crimping of the tubercles and gives a false appearance of lines bounding polygonal tesserae. This specimen may possibly have been interpreted by McCoy as part of the shield of his supposed Cephalaspidian, *Rhytidaspis murrayi*.

Observations.—This species is named in honour of Mr. Reginald Murray, who discovered the first evidence of it at Mansfield many years ago. Most of the remains of *Gyracanthides* in the collection evidently belong to it, though some fragments may perhaps represent other species which cannot yet be distinguished.

Family ACANTHODIDÆ.

Genus ACANTHODES, Agassiz.

[Rech. Poiss. Foss., vol. ii., pt. i., 1833, p. 19.]

A typical slender species of this genus is represented in the Mansfield collection by an imperfect trunk and other fragments. It evidently belongs to the group which is characteristic of the Carboniferous and Permian formations in the northern hemisphere.

ACANTHODES AUSTRALIS, sp. nov. Plate V, fig. 3; Plate VII, fig. 1.

Type.—Caudal region of fish (Pl. VII, fig. 1).

Specific Characters.—A very slender species probably attaining a length of not less than 0.3 m. Anal fin-spine much larger than the dorsal fin-spine, which is more curved and inserted further back than the former. Depth of hinder end of caudal

pedicle somewhat exceeding one-third of the length between the anal fin-spine and the lower lobe of the caudal fin. Scales very small, equilateral, flat and smooth.

Description of Specimens.—The type-specimen, of which the greater part is shown in Pl. VII, fig. 1, is associated with the imperfect trunk of a similar fish on a small block of sandstone which has unfortunately been weathered. The extreme slenderness of the trunk and the elongation of the upper caudal lobe are indicated; but the only remains of fins are fragments of the dorsal, anal and caudal. The dorsal fin-spine, just in front of a crack in the fossil, is clearly much smaller, more curved, and more remote than the anal fin-spine, which is incomplete distally. Both these spines are broken, and the anal spine (enlarged in fig. 1*b*) displays its extensive internal cavity. The caudal fin (enlarged in fig. 1*a*) seems to be nearly complete in the upper lobe, but lacks the greater part of the lower lobe. A larger specimen of the tail (Pl. V, fig. 3) is similarly imperfect. The very small scales are nearly or quite square, and most of them are exposed from the inner face, which exhibits its usual convexity (Pl. VII, figs. 1*c*, 1*d*). In one part of the fossil their outer face is distinctly shown to be flat and smooth (Pl. VII, fig. 1*e*). On the membranous expansion of the caudal fin they become minute (Pl. V, fig. 3*a*). In the original of Pl. V, fig. 3, the lateral line can be traced to the basal portion of the upper caudal lobe, and is only marked by a ridge-like displacement, not by an enlargement of the scales.

Genus EUPLEUROGMUS, McCoy.

[Ann. Rep. Sec. Mines, Victoria, 1889 (1890), p. 24.]

An indefinable large Acanthodian with smooth scales, of which two series are deepened and meet chevron-wise along the course of the lateral line.

The peculiar enlargement of the scales of the lateral line characterising this genus, has only been observed hitherto in certain primitive species of Diplacanthidæ from the Lower Old Red Sandstone of Scotland, described under the generic name of

Euthacanthus by Powrie¹. The resemblance, however, does not necessarily imply any close affinity. The fins must be discovered before the precise systematic position of this fish can be determined.

EUPLEUROGMUS CRESSWELLI, McCoy. Plate V., fig. 4.

1890. *Eupleurogmus cresswelli*, F. McCoy. *Loc. cit.*, p. 24.

Type.—Portion of squamation (Pl. V, fig. 4).

Description of Specimen.—As shown by the figure, which is of the natural size, this must have been a rather large Acanthodian; but it is only known by scattered remains of the scales and a fractured fin-spine of one individual. Many of the scales of the flank are in undisturbed order and exhibit their regular arrangement. They are square and apparently solid, with a smooth outer face. Immediately above and below the course of the lateral line, two of them are fused into an elongated scale; the upper fusion being of scales in contiguous transverse series, while the lower fusion affects two scales of one and the same series, the result being that the enlarged scales are disposed chevron-wise, pointing forwards. At the lower left-hand corner of the figure the tip of a fin-spine is represented. The adjoining part of the fossil exhibits the remainder of this spine, which is only seen in longitudinal section. It is as stout and straight as some of the fin-spines of the Lower Devonian *Euthacanthus*, and has a large internal cavity.

Subclass DIPNOI.

Order Sirenoidei.

Family CTENODONTIDÆ.

Genus CTENODUS, Agassiz.

[Rech. Poiss. Foss., vol. iii., 1838, p. 137.]

The characteristic cranial roof and scales of this typically Permo-Carboniferous genus occur in the collection from Mansfield, and permit its identification with certainty.

¹ J. Powrie, Quart. Journ. Geol. Soc., vol. xx. (1864), p. 425.

CTENODUS BREVICEPS, sp. nov. Plate VIII, fig. 12; Text-fig. 3.

Type.—Hinder part of cranial roof (Text-fig. 3).

Specific Characters.—Median occipital plate more than two-thirds as broad as long, and its extreme length about equalling that of the pair of plates immediately in front.

Cranial Roof.—The roofing bones of the hinder half of the skull are partly preserved in the type-specimen (Text-fig. 3), partly shown as an impression of their outer face on the matrix. The impression proves that they were not externally ornamented, their only markings being the usual fine radiating lines of growth, which cause the sutures between the various elements to be plainly visible. The median occipital plate (O) is shaped as in the typical *Ctenodus cristatus* from the English Coal Measures,¹ but differs in being rather broader in proportion to its length. The posterior median pair of plates (I) also agree with those of the type-species except that they are relatively broader; and there seems to have been the usual small median plate (O¹) between their divergent anterior ends. There is nothing worthy of remark concerning the lateral paired plates (II, III) so far as they are preserved, except that they likewise prove the skull to have been shorter and broader than in the type-species just mentioned.

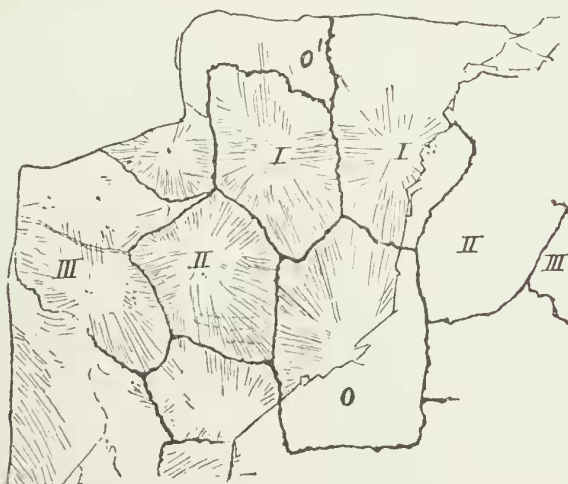


Fig. 3.—*Ctenodus breviceps*, A. S. Woodw.; part of occipital end of cranial roof, three-quarters nat. size. O, median occipital plate; O¹, position of small median plate further forwards; I, II, III., paired plates.

¹ A. S. Woodward, "Catal. Foss. Fishes B.M.," pt. ii. (1891), p. 252, pl. iv., fig. 1.

Vertebral Axis.—One fragment of the abdominal region of a Dipnoan large enough to have belonged to the head just described, exhibits a few very stout, curved ribs like those of the typical *Ctenodus* and *Sagenodus*. These ribs are round in section, with the central cavity which is always observable in the fossilised state. Two portions of a corresponding type of caudal region occur, one being an obscure fragment represented in Pl. VIII, fig. 12, the other a tolerably well-preserved extremity of the tail. These specimens demonstrate the absence of vertebral centra, and exhibit stout, mesially-constricted, neural and hæmal arches and fin-supports, which are only superficially calcified. The tail is clearly diphycceral.

Squamation.—The portion of abdominal region already mentioned exhibits impressions of large, thin scales, resembling those of *Ctenodus* found in the English Coal Measures.¹ The characteristic shape, thinness, and flexibility of these scales are still better seen in another piece of limestone, which contains some fragments of them. They display the usual very fine, radiating structural lines, which are crossed by the coarser and more irregular concentric lines of growth, without any enamel or ornamentation.

Subclass TELEOSTOMI.

Order Crossopterygii.

Family RHIZODONTIDÆ.

Genus STREPSODUS, Young.

[Quart. Journ. Geol. Soc., vol. xxii, 1866, p. 602.]

Numerous remains of a large Rhizodont fish are contained in the collection, and among them it is easy to recognise the scales and teeth of a new species of *Strepsodus*. This genus has hitherto been found only in the Carboniferous of the northern hemisphere.

¹ Hancock and Atthey, Nat. Hist. Trans. Northumb. and Durham, vol. iv. (1872), p. 398, pl. xiii, fig. 3; p. 417, pl. xvi.

STREPSODUS DECIPIENS, sp. nov. Plate VII., figs. 2, 3; Plate VIII, figs. 1-11.

Type.—Scales (Pl. VIII, fig. 10).

Specific characters.—Scales with the radiating ridges and furrows on the exposed portion more numerous than in the European Carboniferous species; the small pits and tubercles on the attached face also apparently more numerous than in the latter. Teeth [from same horizon as scales and presumably of same species] rather large, stout, and nearly or quite smooth, with the apex a little incurved but not sigmoidally bent.

Scales.—The scales exhibit the usual variations in form, according to their original position on the trunk of the fish, and are all more or less round or oval, with a slight truncation at the anterior border. Most of them are preserved in a partially decayed condition, and they then exhibit their internal structure, as represented in Pl. VIII, figs. 5, 6, 6*a*, 7, 10, 11. The exposed sector, seen in the lower half of these figures, is not very wide. Its tissue is coarser than that of the rest of the scale, consisting of stout radiating rods, which are closely apposed and crossed by a few feeble strands concentric with the border. The other part of the scale consists of very numerous radiating and concentric strands of tissue of about equal fineness. The difference between the two structures is well shown in the magnified drawing, fig. 6*a*, where a portion of the covered area is seen to the left, a larger portion of the exposed sector to the right. The outer face of the scale is rarely observable, even as an impression on the rock; but an imperfect scale associated with the original of fig. 10 (the type specimen) seems to show that each radiating rod of the exposed sector was surmounted by a delicate superficial ridge, the total number of ornamental radiating ridges being thus considerably more than in any scale of *Strepsodus* hitherto described. When a complete view of an impression of the inner face is obtained (as in the group represented in fig. 9), there is clear evidence of the large, antero-posteriorly elongated tubercle so characteristic of the middle of the scale in this and some allied genera. Occasionally, as in the piece of undisturbed squamation

impressed on the original of fig. 8, the hinder sector of the inner face is shown to have been covered by fine pittings and tubercles, which are apparently more numerous than in the known scales of *Strepsodus*. The slime-canal of the lateral line must have been large, as shown by its mould (fig. 10).

Jaws and Teeth.—The collection includes only two portions of mandible and a few imperfect teeth, which are noteworthy as being large compared with the scales just described. The height of the largest laminary tooth is 0.05 m., while the maximum diameter of the largest scale is 0.045 m. The remains are sufficiently well preserved to exhibit the characteristic form and structure of a Rhizodont mandible, and the larger of the two specimens is represented from the outer aspect in Pl. VIII., fig. 1. The dentary bone is a thin lamina with traces of an external tubercular ornament. Its oral margin bears a single regular series of small conical teeth, which are very slightly compressed antero-posteriorly and are scarcely incurved at the apex. These teeth are typically Rhizodont, with folded base and small pulp-cavity. Evidence of the shuttle-shaped bones bearing the laminary teeth is seen in both specimens; and one of these elements bearing two teeth (namely, one laminary with the successor by its side) is imperfectly represented near the front end of Pl. VIII, fig. 1. Like the smaller teeth the laminary teeth are not sigmoidally bent, but only incurved at the apex. They are rather stout, and when viewed in longitudinal section (figs. 1*a*, 2, 3) they exhibit the usual pulp-cavity with simple foldings of the wall at the base. Transverse thin sections of the teeth, when magnified, show clearly the simple character of the basal folds (fig. 4) and the absence of all folding in the upper part where the pulp-cavity still persists (fig. 4*e*). The ordinary thin vertical splenial lamina occurs on the inner face of the mandible.

Jugular Plates.—There are several remains of the characteristic paired jugular plates of a large Crossopterygian fish, and the two best specimens are shown in Pl. VII, figs. 2, 3. They also probably belong to *Strepsodus decipiens*, since it is the only large Crossopterygian identifiable in the collection from Mansfield. The original of Pl. VII, fig. 2, is an impression of the inner face

of a plate, which must have been about three times as long as broad, with sharply rounded ends and a feebly crimped or folded edge. The original of fig. 3 is an imperfect ferruginous fossil, evidently incomplete at one end and at one lateral margin. A third specimen shows the actual spongy tissue of the bony plate, with indications of an irregular tubercular ornament on the outer face. It seems likely that these specimens were misinterpreted by McCoy, and were intended for description under the name of *Pteraspis? mansfieldensis* (*loc. cit.*, p. 24).

Appendicular Skeleton.—In addition to the Rhizodont fragments just described, there is a typical small clavicle, bearing an external ornament of radiating rugæ and tubercles. There are also three stout, hour-glass-shaped internal bones, exactly resembling the basal supports of the paired, dorsal, and anal fins in the Rhizodonts and their allies.

Order Actinopterygii.

Family PALÆONISCIDÆ.

Genus ELONICHTHYS, Giebel.

[Fauna der Vorwelt, Fische, 1848, p. 249.]

Syn. *Cosmolepides*, F. McCoy, *loc. cit.*, 1890, p. 24 (name only).

All the remains of Palæoniscidae from Mansfield appear to belong to this genus, which is found both in Europe and North America, and ranges from the Lower Carboniferous to the Lower Permian.

ELONICHTHYS SWEETI, sp. nov. Plate IX, figs. 1-3; Plate X. 1890. *Cosmolepides sweeti*, F. McCoy, *loc. cit.*, p. 24 (name only).

Type.—Imperfect fish, the greater portion of the trunk in counterpart (Pl. IX, fig. 1; Pl. X, fig. 1).

Specific Characters.—A slender species attaining a length of at least 0.3 m., probably sometimes larger. Length of head with

opercular apparatus equalling nearly one-quarter of the total length of the fish and somewhat exceeding the maximum depth of the trunk; caudal pedicle slender, less than half as deep as the abdominal region. Distance between the origin of the paired fins equal to that between the origin of the anal and caudal fins; dorsal completely in advance of anal fin. External ornament chiefly of striæ; teeth stout. Principal scales of flank not deeper than broad, with straight upper and lower edges; outer face of all the scales completely ornamented with fine, somewhat oblique ridges, which terminate in the delicate serrations of the posterior border; the ridges on the flank-scales nearly parallel, though often bifurcating and intercalated; those on the lower half of the narrow ventral scales curved upwards at the front border, and most of them terminating behind at the diagonal which joins the antero-superior and postero-inferior angles.

General Form.—The type-specimen is distorted in the ventral part of the abdominal region and incomplete dorsally; but the original outline of the fish would probably be almost as represented in the diagrammatic sketch, Pl. IX, fig. 3. The tail is shown to be inequilobate, as usual in *Elonichthys*.

Head.—Although the form and proportions of the head are indicated in the type-specimen, its details are obscure and only in part traceable. The greater portion of the cranial roof is shown as an internal cast, with the mark of the longitudinal slime-canal traversing its frontal element; but a fragment of a plate posteriorly bears a finely rugose or striated ornament. The orbit was situated far forwards, as proved by an impression of two of the circumorbital plates. The outer face of the maxilla is not preserved, but its oral border is distinct, curving downwards at the hinder end and bearing impressions of very stout conical teeth (Pl. IX, fig. 1*c*). Its great postorbital expansion is about three times as long as deep. The slender mandible is very imperfect, but fragments of the bone in its hinder part seem to show an ornament of longitudinal striations. The characteristic narrow opercular apparatus is recognisable, with occasional traces of a striated ornament. The forwardly-curved preoperculum is

traversed by the usual well-developed slime-canal, while the suboperculum is relatively deep.

Appendicular Skeleton.—The supraclavicle and clavicle are seen in the type-specimen as moderately wide plates, which are ornamented with fine ridges or striations disposed in the direction of the long axis of these bones. There are also remains of the pectoral fins, which show that all their rays were articulated, though not very closely, for the greater part of their length. Both pelvic fins are likewise imperfectly preserved, arising slightly nearer to the anal fin than to the pectorals. Each comprises at least 28 rays, of which all are articulated to the base, although the length of the spaces between the joints considerably exceeds their width. The dorsal and anal fins must have been nearly equal in size and shape, the former completely in advance of the latter. They are short and deep, comprising from 25 to 30 rays, which exhibit distant articulations. Traces of the fringe of small and delicate fulcra are seen on the anal fin in the type-specimen. The caudal fin is imperfect in this specimen, and the inequality of its lobes is better seen in the original of Pl. IX, fig. 1a. The lower lobe is fringed with a close series of delicate fulcra, and its rays are very finely divided distally. It is uncertain whether any of the fin-rays were ornamented, but sometimes they appear to bear indications of fine longitudinal ridges.

Scales.—The principal scales on the flank of the abdominal region are shown by the type-specimen to be about as deep as broad. Those on the caudal region are somewhat broader than deep, while those near the ventral edge of the fish are at least twice as broad as deep. Those of the flank are united by a large and broad peg-and-socket articulation (Pl. X, figs. 1, 1a, 1b). Isolated scales on several specimens show that their overlapped anterior border was narrow, as usual in *Elonichthys*. The outer face of all the scales is completely covered with ganoine, which forms numerous delicate rounded ridges separated by little sharp clefts. These ridges have a general oblique, antero-posterior trend, and terminate at the hinder edge of each scale in feeble serrations. They often exhibit a tendency to curve upwards in

front; while not uncommonly they are inconspicuous on the middle of the scale, which then becomes smooth (Pl. IX, fig. 1*b*; Pl. X, figs. 1*c*, 1*d*, 1*e*, 1*f*). The direction of the ornamental ridges is least oblique and most regular on the principal abdominal flank-scales (Pl. IX, fig. 1*b*; Pl. X, figs. 1*e*, 1*f*); much more oblique or even diagonal on the principal caudal scales (Pl. X, figs. 1*c*, 1*d*, 2*a*, 2*c*). The characteristic arrangement on the ventral scales is indicated in Pl. X, fig. 2*b*. The narrow, diamond-shaped, small scales of the upper caudal lobe are ornamented by fine, diagonal ridges, as shown by impressions in the type-specimen and in the original of Pl. IX, fig. 1*a*. The enlarged ridge-scales are not seen in the type-specimen, but some of those in advance of the anal fin are shown in the original of Pl. X, fig. 2.

Remarks.—The impression of an imperfect, relatively large trunk represented in Pl. X, fig. 2, is not referable to this species with certainty; but the shape and ornamentation of the scales seem to agree precisely with those of the fish now described. This and the type-specimen were found by Mr. George Sweet, in whose honour the species is named.

ELONICHTHYS GIBBUS, sp. nov. Plate IX, fig. 4; Plate XI.

Type.—Imperfect fish, lacking end of tail (Pl. XI, fig. 1).

Specific characters.—A short, deep-bodied species with comparatively small head, attaining a length of about 0.2 m. Length of head with opercular apparatus somewhat less than the maximum depth of the trunk, which is contained twice in the length from the pectoral arch to the base of the caudal fin. Pelvic fins arising about midway between the pectorals and the anal; dorsal and anal fins at least as long as deep, the former not completely in advance of the latter. Principal scales of flank in abdominal region slightly deeper than broad; outer face of all the scales completely ornamented with fine, somewhat oblique ridges, which terminate in the delicate serrations of the posterior border. Enlarged dorsal ridge-scales apparently extending as far forwards as the occiput.

General Form.—As shown by the type-specimen and the original of Pl. IX, fig. 4, the deepest part of the trunk of this species is at the origin of the dorsal fin, which is remarkably large and extended. The other specimens are more imperfect or distorted during fossilisation.

Head.—The small head is partly indicated in the type-specimen, but better shown in another impression (Pl. XI, fig. 3). The fine ornament on at least the frontal region of the cranial roof is partly subdivided into tubercles. The other external bones are only striated, the striae on the maxilla and mandible being mainly horizontal or longitudinal, those on the circum-orbital plates (Pl. XI, fig. 3*b*) radiating. The maxilla bears large, stout teeth, and its postorbital expansion is about two-and-a-half times as long as deep. The opercular apparatus must have been very narrow.

Appendicular Skeleton.—The supraclavicle, clavicle and infra-clavicle, seen in the type-specimen (Pl. XI, fig. 1), are moderately wide plates, ornamented with fine ridges or striations disposed in the direction of the long axis of these bones. The length of the pectoral fins can scarcely have exceeded half that of the head with opercular apparatus. The pelvic fins seem to have been as large as the pectoral pair. The dorsal and anal fins are remarkably large and extended, the former arising at the highest point of the back and always depressed backwards in the fossils. More than 40 rays are indicated in the imperfect dorsal fin of the type-specimen, and more than 30 rays are seen in the anal fin in the original of Pl. IX, fig. 4. The articulations of all the fin-rays are distant.

Scales.—The slight deepening of the principal scales of the flank in the abdominal region is observable both in the type (Pl. XI, fig. 1*a*) and in other specimens. The finely-striate ornamentation of the scales resembles that already described in *Elonichthys sweeti*, but there is never an indication of median smoothness.

EXPLANATION OF PLATES.

PLATE I.

Fig. 1.—*Gyracanthides murrayi*, sp. nov.; one side of type-specimen, showing anterior free pectoral spine (*a*), oval plate closing base of posterior free pectoral spine (*b*), pectoral fin-spine chiefly in impression (*c*), and dermal tubercles (*d*); nat. size.

1*a*.—Diagrammatic drawing of horizontal section of dermal tubercles, showing the pulp-cavity; about three times nat. size.

Fig. 2.—Ditto; impression of anterior free pectoral spine, showing external tubercular ornament and narrow smooth inserted base; nat. size.

Fig. 3.—Ditto; impression of a larger incomplete specimen; nat. size.

Fig. 4.—Ditto; abraded imperfect specimen, outer aspect, showing texture, nat. size; also the same, twice nat. size (4*a*), and one ridge further enlarged (4*b*).

Fig. 5.—Ditto; imperfect impression of outer aspect; nat. size, and also twice nat. size. (5*a*).

Fig. 6.—Ditto; two ridges of the preceding specimen; much enlarged.

Fig. 7.—Ditto; ventral aspect of trunk, lacking head and end of tail, showing internal mould of one anterior free pectoral spine (*a*), impressions of part of both pectoral fin-spines (*b*, *b*¹), internal moulds of the pelvic fin-spines (*c*, *c*¹), impressions of some ventral dermal tubercles (*d*), and both internal and external moulds of the small, apparently displaced, anal fin-spine (*e*); two-thirds nat. size.

7*a*.—Internal mould of anterior free pectoral spine; nat. size.

7*b*.—Outer view of dermal armour, showing rounded bosses on the tubercles; magnified.

Fig. 7c.—Mould of anal fin-spine, indicating the large dimensions of its internal cavity; nat. size.

7d.—Impression of ornament of lateral face of anal fin-spine, showing the nearly parallel tuberculated ridges terminating successively at its anterior edge; nat. size.

PLATE II.

Fig. 1.—*Gyraconthides murrayi*, sp. nov.; impression of region of pectoral fin, showing the finely tuberculated outer face of the posterior free pectoral spine (*a*); the greater part of a pectoral fin-spine, with its base (*b*) partly marked by overlying dermal tubercles, its exerted portion (*c*) slightly incomplete at the outer edge and at the distal end; also a small patch of dermal tubercles (*d*); nat. size.

1a.—Internal mould of the posterior free pectoral spine, taken from the hollow marked (*a*) in fig. 1; seen from the outer-lateral face, lacking the apex but showing the radiating structural lines and the bevelling of the anterior margin of the spine; nat. size.

1b.—The same spine, with piece of matrix, seen from behind, showing its lateral compression; nat. size.

1c.—The elongate-oval plate, with radiating structural lines, closing the aperture of the central cavity of the same spine; nat. size.

1d.—Structural lines of the same spine; magnified.

1dd.—Diagram of hollows in matrix left by decay of dermal tubercles, the sharp separating lines not seen in the original; magnified.

1e.—Fine tubercular ornament seen in cavity of fossil at *a*.

1f.—Diagram of outer aspect of dermal tubercles; magnified, the crimping somewhat exaggerated.

Fig. 2.—Ditto; impression of part of abdominal region, showing mould of pelvic fin-spines, incomplete behind (*a, a*), part of both pectoral fin-spines (*b, b*), and some dermal tubercles (*c*); nat. size.

2*a*.—Cross-section of mould of pectoral fin-spine just beyond the hinder end of its inserted portion, with matrix occupying position of the groove on its narrow posterior face; nat. size.

2*b*.—Similar cross-section near hinder end of pelvic fin-spine, showing its slight compression and an indication of the postero-internal groove; nat. size.

2*c*.—Diagram of outer aspect of dermal tubercles with rounded bosses; five times nat. size.

2*d*.—Diagram of tuberculated ridges of paired fin-spine; magnified (not satisfactory, the intervening grooves scarcely wide enough).

2*e*.—Cross-section like 2*a*, but near the anterior end of the pectoral fin-spine; nat. size.

PLATE III.

Fig. 1.—*Gyracanthides murrayi*, sp. nov.; portion of abdominal region showing remains of pectoral fin-spines with their slender distal end appearing vaguely through the hard matrix; numerous dermal tubercles (*a*); the pelvic fin-spines, evidently approximated by crushing, in part preserved, in part as impressions of the outer face (*b*); and a trace of the plate at the base of the posterior free pectoral spine (*c*); nat. size.

1*a*.—Gutta-percha impression of the same specimen, showing the rounded shape and characteristic ornament of the bases of the pelvic fin-spines; nat. size.

1*b*.—Longitudinal broken section of the pectoral fin-spine of the same specimen, showing its fibrous structure; nat. size.

PLATE IV.

Fig. 1.—*Gyracanthides murrayi*, sp. nov.; impression of part of large pectoral fin-spine, incomplete at both ends, but showing a long extent of the narrow, smooth base of insertion (top of figure); nat. size.

1a, 1b, 1c.—Gutta-percha impression of the same fossil, upper or lower view, sharp outer edge, and grooved inner face respectively; nat. size.

1d.—Part of the tuberculated, ridged ornament of the same; thrice nat. size.

PLATE V.

Fig. 1.—*Gyracanthides murrayi*, sp. nov.; caudal region in side view, with remains of abdominal region, showing part of one pelvic fin-shape (*a*) with the tip of the other (*b*); traces of the anterior dorsal fin and its spine (*c*); the posterior dorsal, anal, and caudal fins; also part of one of the posterior free pectoral spines; nat. size.

1a.—Fragment of basal end of pelvic fin-spine, showing hollow mould before it was completely uncovered; slightly magnified.

1b.—Diagram of outer aspect of dermal tubercles; four times nat. size, with the bosses represented of too angular a shape.

Fig. 2.—Ditto; fragment of trunk, apparently drawn upside down, displaying dermal tubercles, the base of a pelvic fin-spine (*a*), and the mould of part of the anterior dorsal fin-spine (on the edge of the fossil but shown separately at *b*); nat. size.

2a.—Partially fractured dermal tubercles, thrice nat. size.

Fig. 3.—*Acanthodes australis*, sp. nov.; caudal fin; nat. size.

3a.—Scales; magnified.

Fig. 4.—*Eupleurognmus cresswelli*, McCoy; portion of type specimen, showing squamation, and also the apex of a fin-spine in the left lower corner; nat. size.

4a.—Scales of middle of flank, showing enlarged scales of lateral line; thrice nat. size.

4b.—Other scales of the same; about twice nat. size.

PLATE VI.

Fig. 1.—*Gyracanthides murrayi*, sp. nov.; impression of tubercular dermal armour; nat. size. Specimen probably intended by McCoy to represent his supposed Cephalaspidian, *Rhytidaspis murrayi*, and the figure wrongly indicating an appearance of polygonal tesserae; nat. size.

1a.—Diagrammatic sketch of impressions of dermal tubercles; thrice nat. size.

PLATE VII.

Fig. 1.—*Acanthodes australis*, sp. nov.; caudal region of type-specimen, showing parts of dorsal, anal, and caudal fins; nat. size.

1a.—Upper lobe of caudal fin; twice nat. size.

1b.—Imperfect anal fin-spine and fin; twice nat. size.

1c, 1d.—Inner aspect of scales; magnified.

1e.—Outer aspect of scales; magnified.

Fig. 2.—*Strepsodus decipiens*, sp. nov.; impression of inner face of jugular plate; nat. size. Specimen probably intended by McCoy to represent his supposed Pteraspidium, *Pteraspis? mansfieldensis*.

Fig. 3.—Ditto; imperfectly preserved jugular plate, incomplete at one side and at one end; nat. size. Also probably regarded as Pteraspidian by McCoy.

PLATE VIII.

- Fig. 1.—*Strepsodus decipiens*, sp. nov.; portion of left mandibular ramus, outer aspect, showing a row of small teeth on the dentary bone, with two imperfectly preserved laniary teeth in close apposition (one tooth and its successor) on an internal bone in front; also another imperfect bone crushed on the anterior end of the jaw; nat. size.
- 1a.—Section of jaw, showing vertical section of laniary tooth with its basal folds.
- Fig. 2.—Ditto; vertical section of upper part of tooth, with indications of pulp-cavity; nat. size.
- Fig. 3.—Ditto; vertical section of laniary tooth in matrix, showing basal folds; nat. size.
- Fig. 4.—Ditto; magnified transverse sections of laniary tooth, showing nature of folds at base (4), minute structure of dentine (4a, 4b), and absence of folds in the upper part where the pulp-cavity still persists (4c).
- Figs. 5-7.—Ditto; abraded and partially decayed scales, displaying inner structure, the originally-exposed sector directed downwards; nat. size.
- 6a.—Scale-structure magnified, part of the exposed sector to the right, covered portion to the left.
- Fig. 8.—Ditto; impression of inner face of undisturbed squamation; nat. size.
- Fig. 9.—Ditto; impression of inner face of scattered scales, showing internal median tubercle; nat. size.
- Fig. 10.—Ditto; abraded and partially decayed scale of lateral line, showing infilled slime-canal; associated with the type-scale, which is not figured; nat. size.
- Fig. 11.—Ditto; scale.
- Fig. 12.—*Ctenodus breviceps*, sp. nov.; impression of part of caudal region, exhibiting neural and hæmal elements of vertebral axis; nat. size.

PLATE IX.

Fig. 1.—*Elonichthys sweeti*, sp. nov.; type-specimen, fish in lateral aspect, lacking dorsal part of abdominal region; nat. size.

1*a.*—Caudal fin of another specimen, showing its inequilateral shape; nat. size.

1*b.*—Imperfect flank scales; thrice nat. size.

1*c.*—Impressions of upper and lower teeth on edge of jaws; about twice nat. size.

Fig. 2.—Ditto; undetermined.

Fig. 3.—Ditto; unsatisfactory attempt at restoration, much reduced, the general outline probably almost correct, but squamation very inaccurate and some other characters doubtful. *br.*, broad branchiostegal rays; *cl.*, clavicle; *d.*, mandible; *f.*, anterior part of frontal; *icl.*, infraclavicle; *io.*, suboperculum; *mx.*, maxilla (expansion too deep); *op.*, operculum; *p.*, hinder part of frontal (internal impression, thus showing longitudinal slime-canal); *pmx.*, bone below the orbit, which is represented too small; *po.*, preoperculum; *pt.*, post-temporal; *scl.*, supra-clavicle; *so.*, circumorbital ring; *zb.*, undetermined bone (no clear evidence).

Fig. 4.—*Elonichthys gibbus*, sp. nov.; imperfect trunk, showing inner aspect of many flank-scales with peg-and-socket articulation, also part of pelvic, dorsal, and anal fins; nat. size.

4*a.*—Remains of scales showing ornamentation; enlarged.

PLATE X.

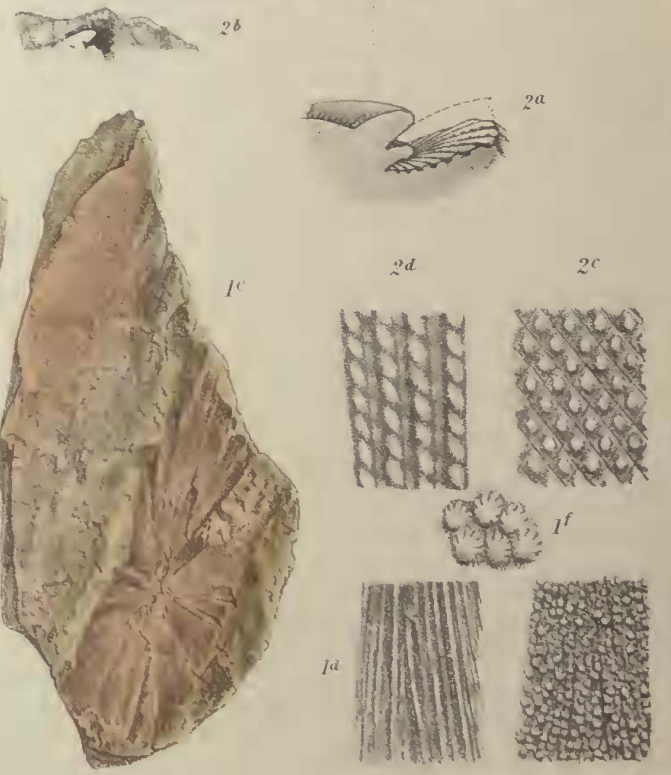
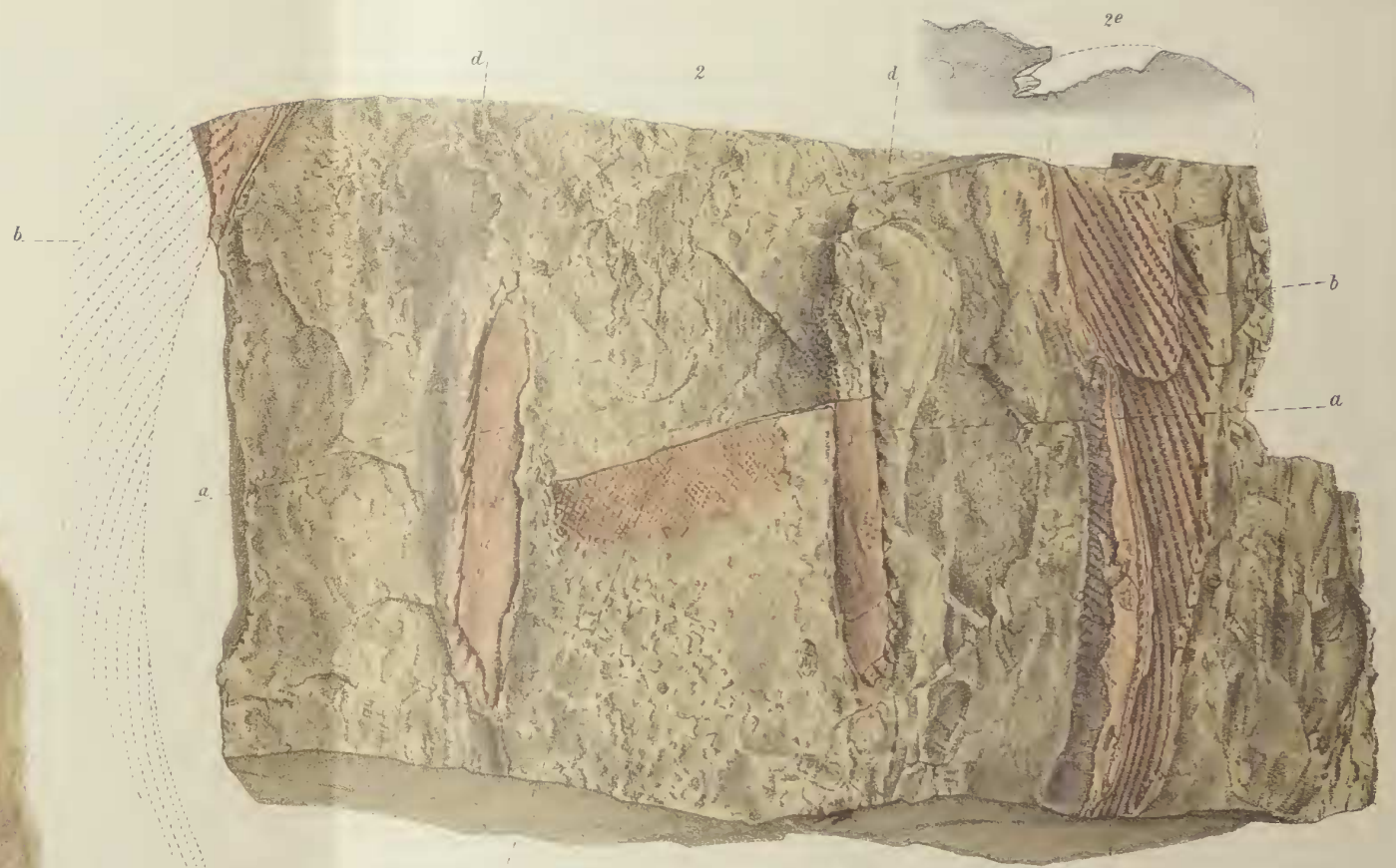
Fig. 1.—*Elonichthys sweeti*, sp. nov.; imperfect counterpart of trunk of type-specimen, showing some scales from inner aspect, with peg-and-socket articulation (A, B), pectoral fin (C), pelvic fin

- upturned (D), part of dorsal fin (E), anal fin (F), and caudal fin; nat. size.
- 1a, 1b.—Inner aspect of scales; about twice nat. size, to show peg-and-socket articulation, and some of the pegs further magnified.
- 1c.—1f.—Impressions of scales; three or four times nat. size, showing nature of external ornamentation.
- Fig. 2.—Ditto; impression of part of large trunk, showing traces of displaced pectoral fin (G), pelvic fins (H), dorsal fin (I), and anal fin (K); nat. size.
- 2a—2f.—Impressions of scales; thrice nat. size, showing nature of external ornamentation (long axis of figs. 2a—2d wrongly placed vertically).

PLATE XI.

- Fig. 1.—*Elonichthys gibbus*, sp. nov.; type-specimen, lacking hinder half of caudal region; nat. size.
- 1a.—Impression of flank-scales; magnified.
- 1b.—Restored drawing of dorsal ridge-scales; magnified.
- Fig. 2.—Ditto; distorted fish; nat. size.
- Fig. 3.—Ditto; impression of part of head and trunk; nat. size.
- 3a.—Impression of scales; magnified.
- 3b.—Impression of circumorbital plates, showing radiating ornamentation; thrice nat. size.
- Fig. 4.—Ditto; part of trunk and fins; nat. size.
- 4a.—Impression of part of two dorsal ridge-scales; magnified.
- 4b.—Impression of flank-scales; magnified (long axis wrongly placed horizontally).
- Fig. 5.—Ditto; fragmentary remains of fish; nat. size.
- Fig. 6.—Ditto; unsatisfactory attempt at restoration; much reduced, the general outline probably almost correct, but squamation inaccurate and restored; extent of paired, dorsal, and anal fins too large.





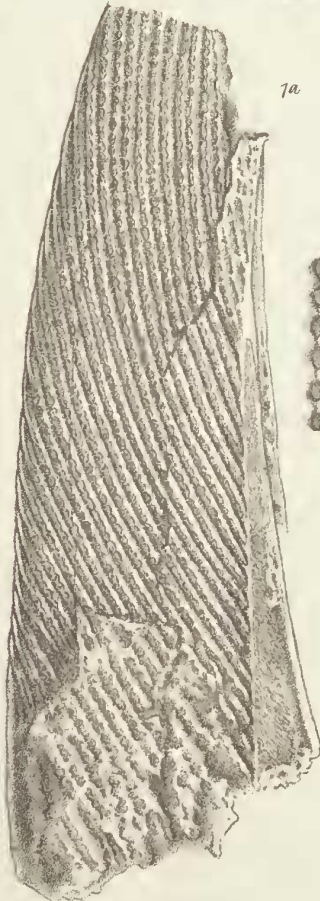
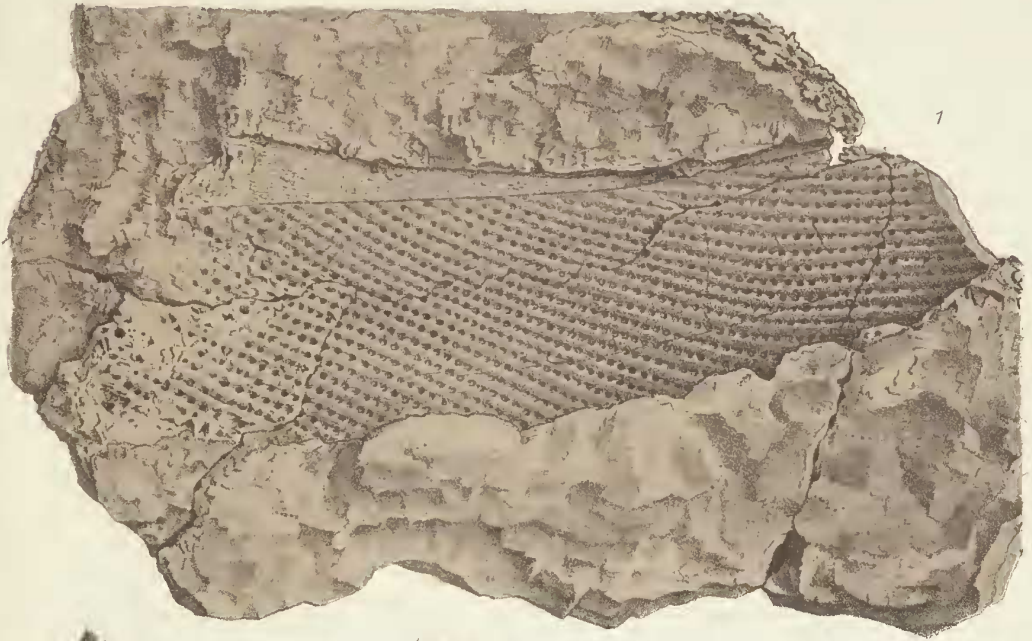


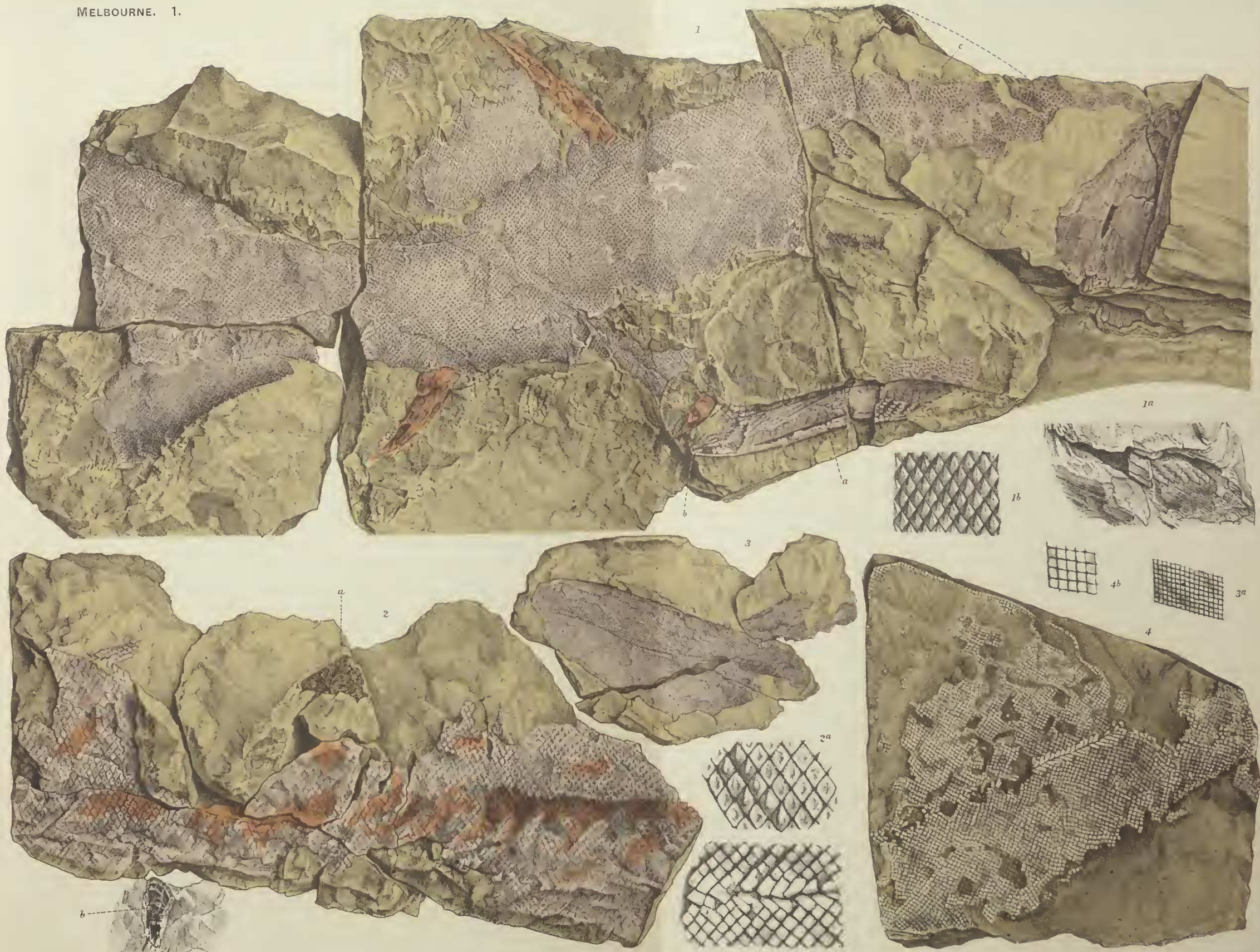
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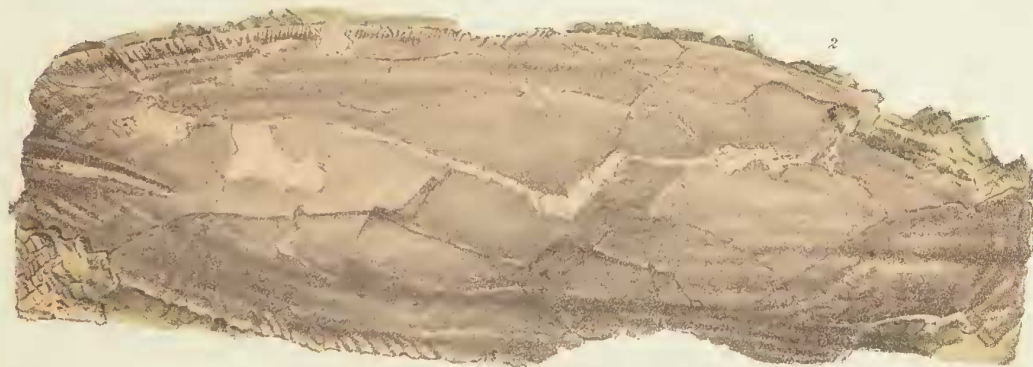
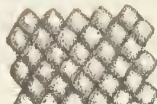
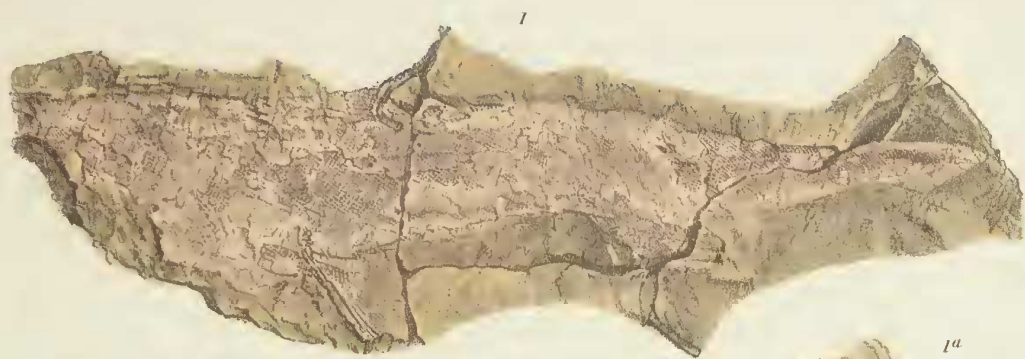


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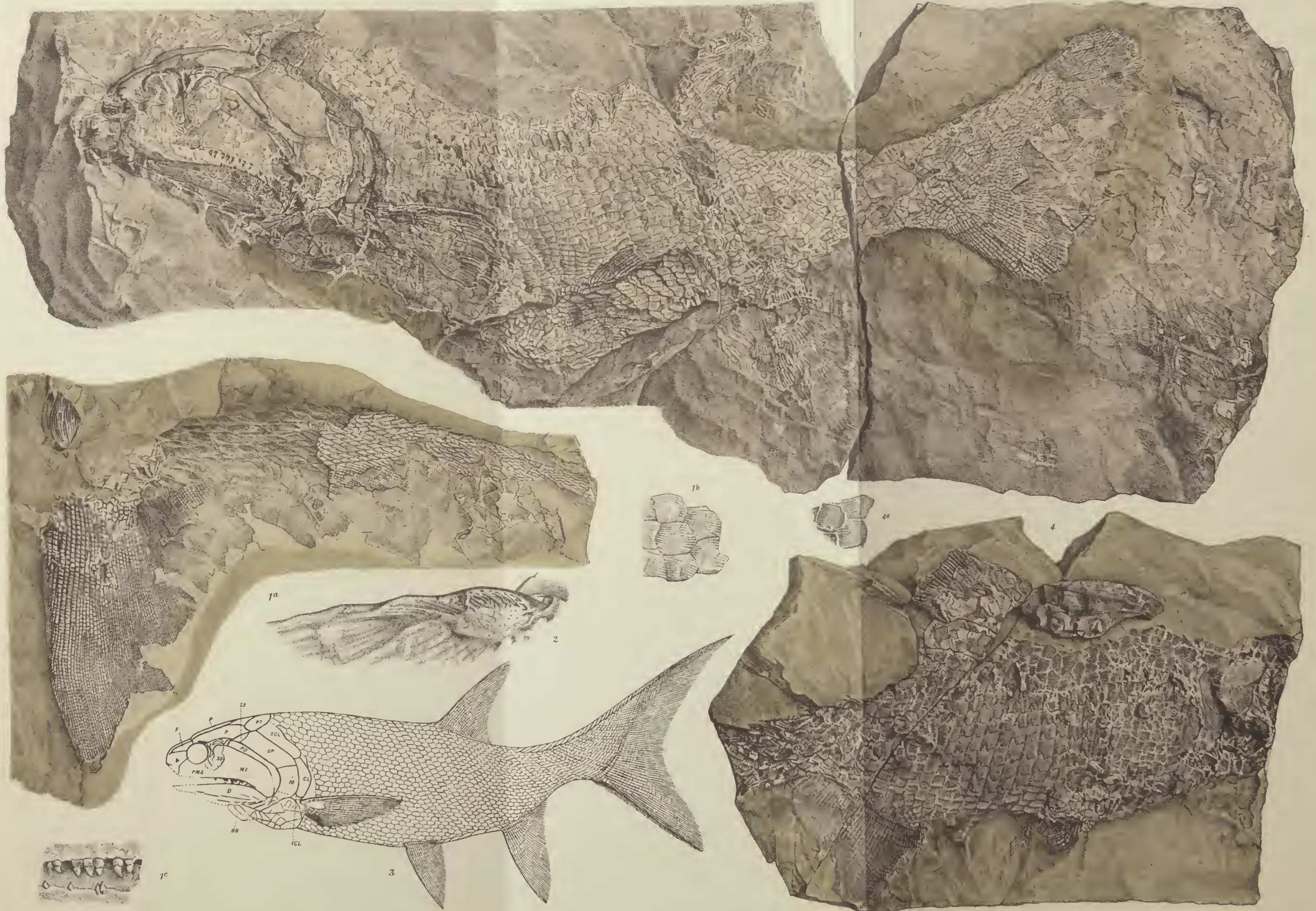
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